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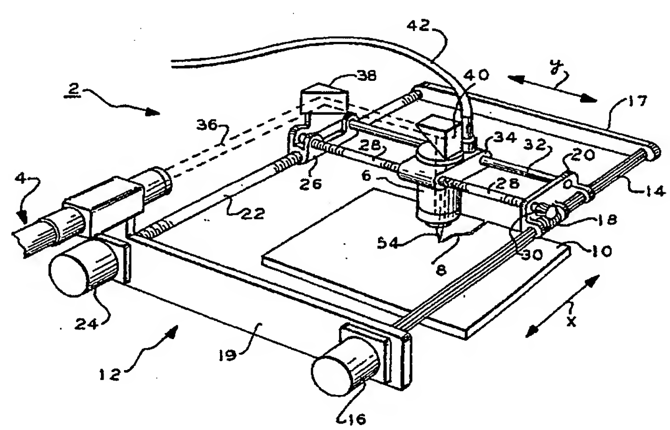
(54) Title: PROCESS FOR FORMING FILM COVERED SHEET METAL MATERIAL AND SHEET METAL MATERIAL SO COVERED



(57) Abstract: A plastic film is bonded with an adhesive to a sheet metal substrate. The sheet metal substrate is processed in a laser operation to form grooves, openings or cuts in the sheet metal. The laser operation has a pressurized gas stream that is directed to the laser beam cut to clean and cool the cut. The gas enters the film-substrate interface at the opening formed by the beam. The film has slits or other perforations throughout so that as the pressurized gas impinges upon the film and its opening formed by the laser beam and enters the film-substrate interface, the adjacent slits bleed the pressurized gas from the film-substrate interface to prevent significant lifting of the film from the substrate into a bubble which otherwise interferes with and can stop the laser operation. The perforations may be in the form of weakened recesses in the film which open in reponse to lifting of the film by gas pressure at the interface with the underlying metal sheet. The dimensions of the perforations are such that the sheet metal is protected during prior handling and the laser processing while maintaining the integrity of the film so it can be easily removed as a unit and not shred during such removal.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

PROCESS FOR FORMING FILM COVERED SHEET METAL MATERIAL AND SHEET METAL MATERIAL SO COVERED

This invention relates to plastic film covered sheet metal that is processed by a laser cutting apparatus.

Sheet metal, e.g., 1/32 inch - ½ inch thick steel, is covered with a protective plastic film, e.g., polyethylene, typically about 0.001 inches to 0.008 inches thick. This film is used to protect the surface of the sheet metal during fabrication and processing. The sheet metal is later processed in a laser cutting apparatus where a computer operated laser beam is incident on the sheet material for processing the material, e.g., cutting including shaping including forming holes or grooves in the material. After the fabrication and processing is completed the protective film is then removed by the user. It is important that the film be readily removed intact as a sheet from the sheet metal as tearing and disintegration of the film during removal is time consuming and not desirable.

Typical laser cutting apparatus includes a high pressure gas stream aimed at the region of the sheet material being cut. The gas stream removes slag as the material is melted and also cools the material where cut. US Pat. No. 3,749,878 discloses a gas assisted laser cutting apparatus of the type described. This patent is incorporated by reference herein. In the disclosed laser cutting apparatus, a laser

beam and a high pressure gas stream are directed at the workpiece through a nozzle and also includes optical means for processing the beam through the nozzle. This apparatus cuts stainless steel and refractory metals and other materials using an exothermically reacting gas. However, such a reacting gas may not always be used in other similar known processes. Such other processes primarily employ a pressurized gas for cooling and clearing the work area of slag.

The laser beam is directed to regions of the sheet material by a computer controlled apparatus. The laser beam is directed at the plastic film cutting through the film as the beam simultaneously cuts the underlying metal sheet.

The problem with this process is that the film, as it is being cut by the beam, also receives the high pressure gas stream. This stream is directed at the same location as the cutting beam by the laser nozzle. Once the plastic film material has a hole cut therethrough by the laser beam, the high pressure gas enters the hole as the sheet metal is being cut. The gas stream then, due to its high pressure, e.g., up to about 250 psi, enters the space between the film and the sheet metal in regions lifting the plastic film above the sheet metal generally in about a 10 inch diameter or greater region around the beam where it impinges upon the film. The adhesive attachment of the film is not permanent and permits such lifting action.

The high pressure gas creates a large bubble, e.g., 10 inch diameter, in the film. This bubble defocuses the laser beam and interferes with the laser cutting operation causing the laser operation to stop, which is unacceptable. The laser then has to be restarted, only to later shut down again by the repetitive creation of bubbles.

The use of slits is known for use in sheet material, but used differently than the plastic slit film used in the present invention described below. For example, in

US Pat. No. 3,655,501 to Tesch, flexible materials are disclosed employing sheet material with at least one adhesive surface. The sheet material is provided with slits in a number of different configurations which allow the sheet material to expand in at least one direction. The sheet material may comprise carpet underlies such as light fleece material, soft or creped sheets, crepe paper, foam, felt or rubber and provided with a non-slip surface. The sheet material is applied to an old floor with one adhesive or non-slip side and holds new flooring in place with a second adhesive side. The slits let the floor breathe freely and provide sound insulation.

The slits give the material a capability to stretch with less tendency to tear for use where curves, contours and difficult surfaces and room shapes are connected together or used as a reinforcement as an air-permeable wrapping for pipes. Also, the material is contemplated for use with sculptured works. The slits permit expansion of the sheet material for use with inclined, overlapped or angular arrangements to provide expansion in more than one direction. It is also contemplated that the slit sheet material is for use with clothing as an insert for shirts in a laminated sheet material to provide dimensional stability for use with multiple sheets of polyamide. Also the slits are provided to provide stiffness in one direction and greater flexibility in another direction. A number of different slit arrangements are disclosed. However, none of the disclosed sheets with slits are disclosed for use with relatively stiff sheet metal which does not exhibit the problems addressed by this patent. This patent does not recognize the problems associated with sheet metal covered by plastic film in a laser cutting process.

US Pats. Nos. 3,749,878 to Sullivan et al., 4,724,297 to Nielsen, 4,891,077 to Roll et al. and 5,565,120 to La Rocca disclose various types of laser cutting methods

and apparatuses, wherein the methods and apparatuses apply a gas stream to the surface of an object while the laser is cutting the object.

US Pat. No. 4,847,181 to Shimokawa discloses a laser marking method. An adhesive film is applied to the surface of a material to be marked and then uses a laser to mark the surface. The laser passes through the material to mark the surface.

US Pats. Nos. 4,469,727 to Loew, 4,615,781 to Boudreau, 4,999,235 to Lunn et al., 5,547,725 to Barrows et al. and 5,810,756 to Montecalvo et al. disclose various other structures and methods generally related to the subject matter of the present invention. For example, Barrows discloses a foam article comprising parallel strips secured to adjacent strips by short lengths. Montecalvo discloses a method of producing a perforated medical adhesive tape. Loew discloses an automotive trim strip with expanded pressure sensitive tape provided with slits.

None of the above prior art patents address or recognize the problem with plastic covered sheet metal being processed in a laser cutting operation.

SUMMARY OF THE INVENTION

Applicant has discovered that by providing slits in the plastic film, the slits permit the pressurized gas entering the interface region between the film and sheet metal to escape without lifting the film sufficiently so as to avoid stoppage of the laser operation. Thus an important advance is provided in this art.

A process for forming a protected metal sheet according to the present invention comprises forming a perforated pliable plastic sheet material film whose perforations are arranged to substantially maintain the integrity of the film and protect the metal sheet; releasably adheringly securing the perforated film to a sheet metal substrate surface to cover and protect the substrate surface; and laser cutting the substrate through the film while simultaneously applying an incident pressurized

gas stream to the film covered substrate at the region where being cut for cooling and cleaning the substrate.

In one aspect, the forming the film step includes applying the adhesive to a surface of the film and then forming slits in the film.

In a further aspect, the film is formed of plastic material having a thickness of about 0.001 to 0.008 inches.

In a further aspect, the perforations are formed to pass partially through the film forming recesses in the film. The film at the recesses protects the underlying metal sheet surface during handling. The recesses then rupture during the laser cutting process to prevent the film from lifting in response to the incident pressurized gas stream. The pressurized gas enters the film-metal sheet interface and bleeds through the ruptured recesses, slits or other perforations to preclude lifting of the film and the stoppage of the laser cutting process.

The step of forming the film may include forming slits in the film having negligible transverse dimension such that the sides of the slit are abutting and an elongated dimension normal to the transverse dimension. The elongated dimension may be in the range of about 0.25 inches to about 1 inch in a plurality of linear rows which may be spaced apart in the range of about 2 to about 4 inches.

In a further aspect, the step of forming the film includes forming perforations in the film arranged so that a pressurized gas stream incident on the film during the cutting substantially escapes from the cut area to adjacent slits beneath the film to minimize interference with the cutting of the metal substrate by the laser.

Preferably, the film is polyethylene, but may be other pliable materials.

In a further aspect, a sheet material adapted for cutting by a laser beam accompanied by an incident pressurized gas stream comprises a sheet of metal

having a surface; and a plastic film adheringly releasably secured to the surface, the film having a plurality of perforations arranged to permit the incident gas stream to escape to adjacent openings during the cutting to minimize interference of the film with the laser beam cutting.

IN THE DRAWING:

FIGURE 1 is a perspective view of a laser cutting apparatus for use in cutting sheet material according to an embodiment of the present invention;

FIGURE 2 is a sectional elevation view of a sheet material covered with a plastic film in the embodiment of Fig. 1;

FIGURE 2a is a sectional elevation view of a sheet material covered with a plastic film in the embodiment of Fig. 1 similar to the view of Fig. 2 and showing an alternative embodiment;

FIGURE 3 is an isometric view of a plastic sheet according to one embodiment of the present invention;

FIGURE 4 is a more detailed sectional elevation view of a laser cutting nozzle and sheet material of the embodiment of Fig. 1; and

FIGURE 5 is a sectional elevation view of the film-substrate during laser cutting of the substrate to illustrate certain principles of the present invention.

In Fig. 1, a schematic representation of a laser apparatus 2 comprises a laser 4 which emits a laser beam of coherent parallel rays supplied to cutting head 6 by optical elements. The head 6 forms a cut 8, which may be a groove, in the sheet material 10. The head 6 is mounted on an X-Y platform 12. The platform 12 includes a splined shaft 14 rotatably driven by a motor 16 and supported in brackets 17, 19. A worm 18 is driven by the shaft 14 and slides along the shaft 14 in the X

directions. A bracket 20 is also slidably secured to the shaft 14. None of the figures are to scale for purposes of illustration.

A screw 22 is rotatably driven by motor 24 and is supported by brackets 17, 19. A bracket 26 is driven in the X directions by rotation of the screw 22. A screw 28 is rotatably supported in brackets 20 and 26 and has a gear 30 rotatably driven by worm 18. A guide shaft 32 is supported by brackets 20, 26. A carriage 34 is mounted on guide shaft 32 and threaded to screw 28. The carriage 34 is moved in the Y directions by screw 28 rotatably driven by the motor 16, worm 18 and gear 30.

The laser 4 emits a beam 36 of coherent parallel laser rays which is incident on prisms 38 and 40 to project the beam 36 to the optics in head 6. A gas supply tube 42 is mounted on carriage 34 for supplying pressurized gas which in one embodiment may be oxygen. The gas is supplied to head 6. The above apparatus is described in the aforementioned US Pat. No. 3,749,878 incorporated by reference herein.

In Fig. 2, sheet material 10 comprises a sheet metal substrate 46 which may be 1/32 inch -1/2 inch thick stainless steel, carbon steel or other sheet metal to be processed by the laser beam 36. The beam cuts the sheet metal to form apertures, grooves or shape the material in a known way. A pliable flexible plastic film 44 is bonded to a surface of the sheet metal substrate 46 by an adhesive 48 in the interface therebetween. The adhesive is of known commercially available material and releasably secures the film 44 to the metal substrate. The film 44 is later removed from the substrate by peeling. The film and adhesive are commercially available. The film preferably is 0.001 to 0.008 inches thick polyethylene, but may be other plastic film materials according to a given implementation.

The film 44, Fig. 3, is rectangular of the same dimensions as the sheet metal substrate 46 for covering the entire sheet metal substrate surface to be protected. The film 44 has a plurality of slits 50. The slits 50 may be arranged in parallel linear rows 52 in one embodiment. The slits may be about 0.75 inches long with ¼ inch spacing between slits in a row in this embodiment. The rows may be spaced apart about 2 to 4 inches. The slits are formed by sharp blades such as razor blades and the like. In this way the slits are formed by edges which normally abut in the sheet film when flat to cover the sheet metal surface during processing and not stressed. However, the film 44 when stressed by underlying gas pressure bubbles at adhesive layer 48 form openings at the slits by spreading the slit edges spaced apart. Thus the slits easily form openings to pass fluid such as pressurized gas therethrough when the film is stressed and flexed by such pressurized gas impinging on the film broad outer surface in the interface with the substrate. The size, shape and spacing of the slits is determined empirically for a given implementation depending upon the pressure of the incident gas and other factors described below, such as the adhesive 48 adherence strength and the flexibility of the film.

The slits are one form of a perforation in the film 44. Other perforations may be circular holes, pin holes or slits of other shapes or recesses partially penetrating the film. The term perforation as used herein includes through cuts in the film and partial cuts forming recesses. In Fig. 2a, for example, metal sheet 46' is covered with a pliable film 45 having a plurality of linear recesses 47 in place of the slits 50, Fig. 3. The film 45 is bonded to a surface of the sheet 46' by adhesive 48'. The recess 47 may have a width of any suitable dimension, for example a width of about 0.010 inches or wider and about 0.006 inches deep for a 0.008 inch thick film,

according to a given implementation. The recesses 47 may be formed by cutting blades as are the slits.

The recesses 47 serve to form a weakened region in the film so that when the film 45 is stressed by underlying gas pressure at the adhesive interface and is lifted, the film will sever or rupture at the recesses 47. In this way, the recesses prevent the underlying metal sheet broad surface from being exposed during processing, protecting the surface. The recesses when ruptured form openings in the film permitting the underlying gas bubble to escape at the region where the metal is being cut by the laser. This action precludes undesirable lifting of the film in a manner to stop the laser process. The term perforation as used herein and in the claims thus includes recesses such as recess 47 and through openings such as slits 50.

In Fig. 1. the cutting head 6 has a nozzle 54. In Fig. 4, the head 6 and nozzle 54 are more fully described in the aforementioned US Pat. No. 3,749,878. The beam 36 impinges upon lens 56 in the head 6 and which focuses the beam 36 onto a mirror 58 which reflects the beam to mirror 60. The mirror 60 reflects the beam 36 through the nozzle 62. The mirror 58 is mounted on a revolving ring 64. The ring 64 is driven by pinion 66. This produces a succession of small circles of the beam where it impinges upon the workpiece material 10. The circles overlap as the beam traverses the material to form a cutting path.

The pressurized gas is supplied to the nozzle at inlet 67 to a diffuser 68 holes 70 to the interior of the nozzle 62. The nozzle 62 creates a high pressure gas stream 72 at its exit port. The aforementioned structure is described more fully in US Pat. No. 3.749.878 incorporated by reference herein. Other embodiments of the head and nozzle are also described in this patent and which are given only by way of example, as other heads and nozzles, not shown, may also be utilized according to a

given implementation. A motor driven pinion 74 and gear teeth 76 on the head 60 body move the head 6 vertically. The gas stream 72 may be provided by a gas at a pressure of up to about 250 lbs./inch ^{2}.

This pressurized stream 72 impinges upon the plastic film at the same location as the beam 78 impinges upon the film 44. Because of the high pressure gas, the prior art film without the slits, once pierced by the laser beam 78, forms a bubble 80 (shown in phantom in Fig. 4). The bubble 80 is created due to the build up of gas pressure in the film-substrate interface. This bubble 80 has been observed to be as large as about 10 inches in diameter and having a height that interferes with the focusing of the beam 78, causing sensors (not shown) to cause the apparatus to stop generating the beam.

However, the slits 50, Fig. 5, forming a plurality of slit through perforations in the film, bleeds the pressurized gas 82 from interface 84. The stream 72 enters the interface 84 via opening 85 and passes into the adhesive 48 interface 84 between the film 44 and sheet metal substrate 46. The gas 82 bleeds into the interface 84 and into the ambient atmosphere through the adjacent slits 50 from the interface 84 without significant lifting of the film 44 from the metal substrate broad surface to which the film is attached. This lifting is insufficient to form a large bubble as occurs without the slits 50 as in the prior art films.

The size and spacing of the slits is determined such that the pressurized gas may pass in the adhesive interface 84 to the next adjacent slits 50 without significant lifting of the film beneath the nozzle 62. This avoids interference with the operation of the laser beam 78.

The slit length, spatial orientation and spacing of the rows is determined in accordance with the film thickness, modulus and composition , type of adhesive

employed (quick stick, peel rheology and strength), gas pressure and size of the gas stream, and related factors to permit the gas to bleed and escape from the adhesive interface to the adjacent perforations without lifting the film significantly from the substrate. Also, the perforations are arranged to maintain the film integrity at the time of removal of the film as discussed below. While some lifting may occur, this is not sufficient to interfere with the operation of the laser. The film, due to its compliance, returns to its adhering position on the sheet surface after the laser beam passes. The size and shape of the slits is also determined by the configuration of a given implementation of laser and sheet metal being cut. While straight slits are shown, the slits may have any shape such as arcuate or other wise and may be any suitable pattern to meet the objective of bleeding gas from the film-substrate interface without interfering with the laser operation. For example, US Pat. No. 3,655,501, incorporated by reference herein, discloses numerous perforation slit patterns that might be useful for practicing the present invention.

It should be understood that the number, shape and dimensions of the slits and other perforations will affect the integrity of the plastic sheet at the time of removal. It is important that the plastic film not tear or rip during removal at the end of the laser cutting process. The film should remain intact as a unit to permit it to be easily removed intact as a unit from the metal sheet surface after laser processing. Thus the dimensions of the perforations, their number, size and spacing all play a significant role in precluding such tearing of the film. Thus the perforations need to be so spaced and dimensioned to permit gas to escape without stopping the laser process, but yet be so dimensioned to maintain the integrity of the film for intact removal later. Also, the slits or other perforations need to be arranged so as to also protect the underlying metal sheet broad surface during handling and processing.

That is. the perforations should not be such a wide expansive open area as to permit the metal sheet surface to be damaged.

Thus while through slits may be used. other perforations may also be used as long as the perforations substantially cover the metal sheet surface to protect the surface during processing. Thus the perforations may not be too large so as to expose and uncover a significant area of the metal sheet to contamination or damage during handling prior to or during the laser process. For example. 1 inch circular diameter openings or ½ inch wide rectangular openings would be unsatisfactory for this purpose although such openings might permit gas to escape as desired.

While plastic films have been disclosed hereinabove. other materials may also be employed for the protective sheet film. Such other material may include paper. non-woven sheet material made of cotton. fibrous material or plastic material embedded with fibrous material and so on. What is important is that the film sheet material protect the underlying sheet metal and is later removable from the sheet metal. Any film material that serves this purpose is intended to be included. the materials given herein being examples.

It will occur to one of ordinary skill that modifications may be made to the disclosed embodiments without departing from the scope of the invention as defined by the appended claims. The description is given by way of illustration and not limitation.

What is claimed is:

1. A process for forming a protected metal sheet comprising:

forming a perforated pliable sheet material film whose perforations are arranged to substantially maintain the integrity of the film and protect the metal sheet:

releasably adheringly securing the perforated film to a sheet metal substrate surface to cover and protect the substrate surface; and

laser cutting the substrate through the film while simultaneously applying an incident pressurized gas stream to the film covered substrate at the region where being cut for cooling and cleaning the substrate.

2. The process of claim 1 wherein the forming the film step includes applying the adhesive to a surface of the film and forming the perforations in the film.

3. The process of claim 1 including forming the film of plastic material having a thickness of about 0.001 to 0.008 inches.

4. The process of claim 1 wherein the step of forming the film includes forming slits in the film having negligible transverse dimension such that the sides of the slit are abutting and having an elongated dimension normal to the transverse dimension in the range of about 0.25 inches to about 1 inch in a plurality of linear rows spaced apart in the range of about 2 to about 4 inches.

5.. The process of claim 1 wherein the step of forming the film includes forming slits in the film having negligible transverse dimension and an elongated dimension normal to the transverse dimension.

6. The process of claim 1 wherein forming the perforations comprises forming recesses extending partially into the film to provide weakening regions at the recesses.

7. The process of claim 1 wherein the step of forming the film includes forming perforations in the film arranged so that a gas stream at a pressure of up to about 250 lb./in^2 incident on the film during the cutting substantially escapes from the cut area to adjacent slits beneath the film to minimize interference with the cutting of the metal substrate by the laser.

8. The process of claim 1 wherein the film is polyethylene.

9. A sheet material adapted for cutting by a laser beam accompanied by an incident pressurized gas stream comprising:

a sheet of metal having a broad surface; and

a film adheringly releasably secured to the broad surface, the film having a plurality of perforations arranged to permit the incident gas stream to escape to adjacent perforations during the cutting to minimize interference of the film with the laser beam cutting.

10. The sheet material of claim 9 wherein the film is plastic and has a thickness of about 0.001 to 0.008 inches.

11. The sheet material of claim 9 wherein the perforations are spaced slits passing through the film.

12. The sheet material of claim 11 wherein the slits having negligible transverse dimension such that the sides of the slit are abutting and having an elongated dimension normal to the transverse dimension in the range of about 0.25 inches to about 1 inch in a plurality of rows spaced apart in the range of about 2 to about 4 inches.

13. The sheet material of claim 11 wherein the slits have negligible transverse dimension such that the sides of the slit are abutting and having an elongated dimension normal to the transverse dimension.

14. The sheet material of claim 9 wherein the perforations are formed to pass partially through the film forming recesses in the film.

15. The sheet material of claim 9 wherein the perforations are arranged so that a gas stream at a pressure of up to about 250 lb./in^2 incident on the film during the cutting substantially escapes from the cut area to adjacent perforations beneath the film to minimize interference with the laser during cutting of the metal sheet material through the film.

16. The process of claim 14 wherein the recesses are linear.

17. The process of claim 11 wherein the slits are linear.

18. The process of claim 9 wherein the film and perforations are arranged to substantially protect the metal sheet broad surface.

19. The process of claim 1 wherein the sheet material film is selected from any one of the group consisting essentially of plastic. fibers embedded in plastic, and fibrous non-woven materials including paper, cotton and other fibrous material.

20. The sheet material of claim 9 wherein the film is selected from any one of the group consisting essentially of plastic, fibers embedded in plastic, and fibrous non-woven material including paper, cotton, and other fibrous material.

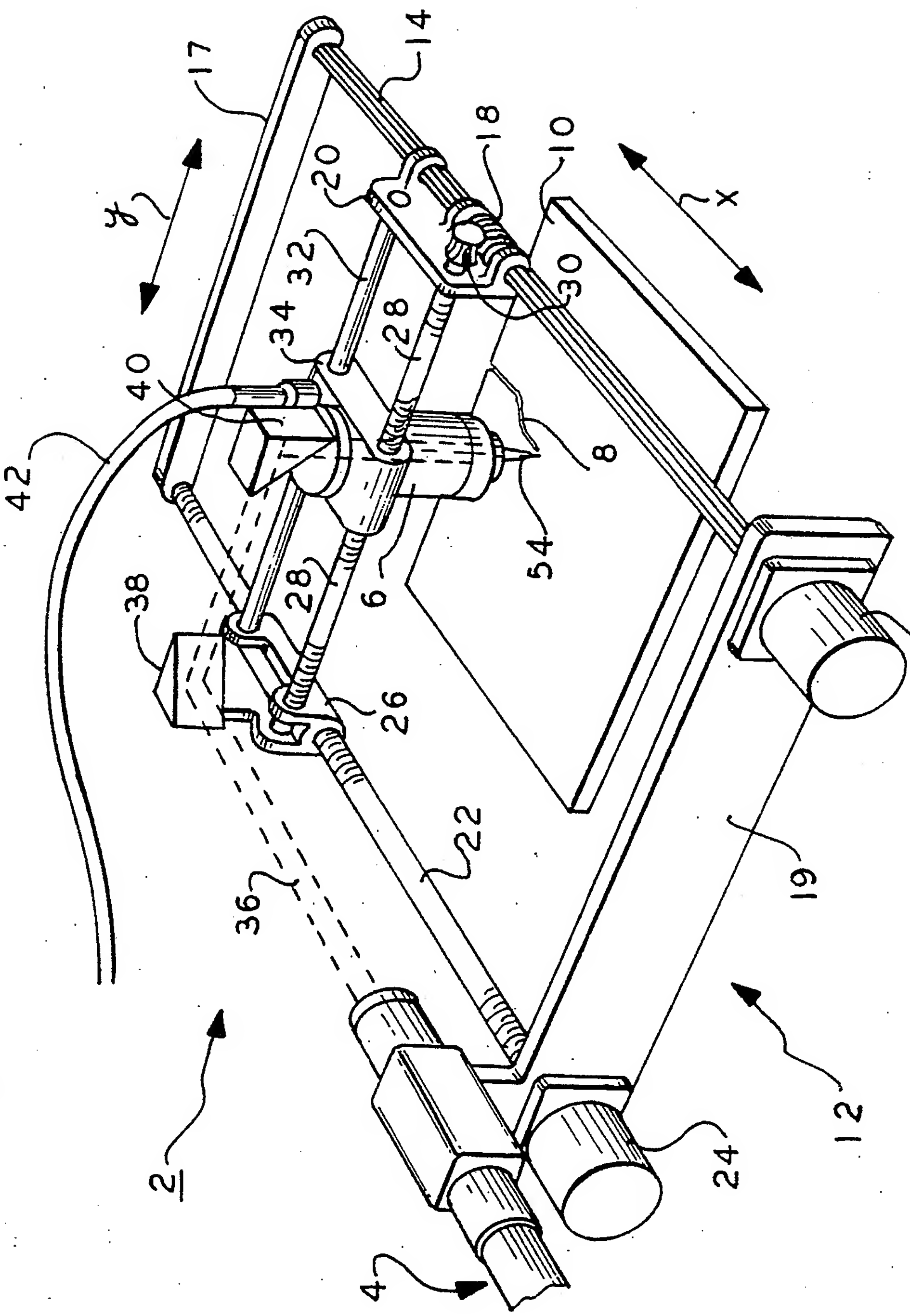

FIG. 1

FIG. 3

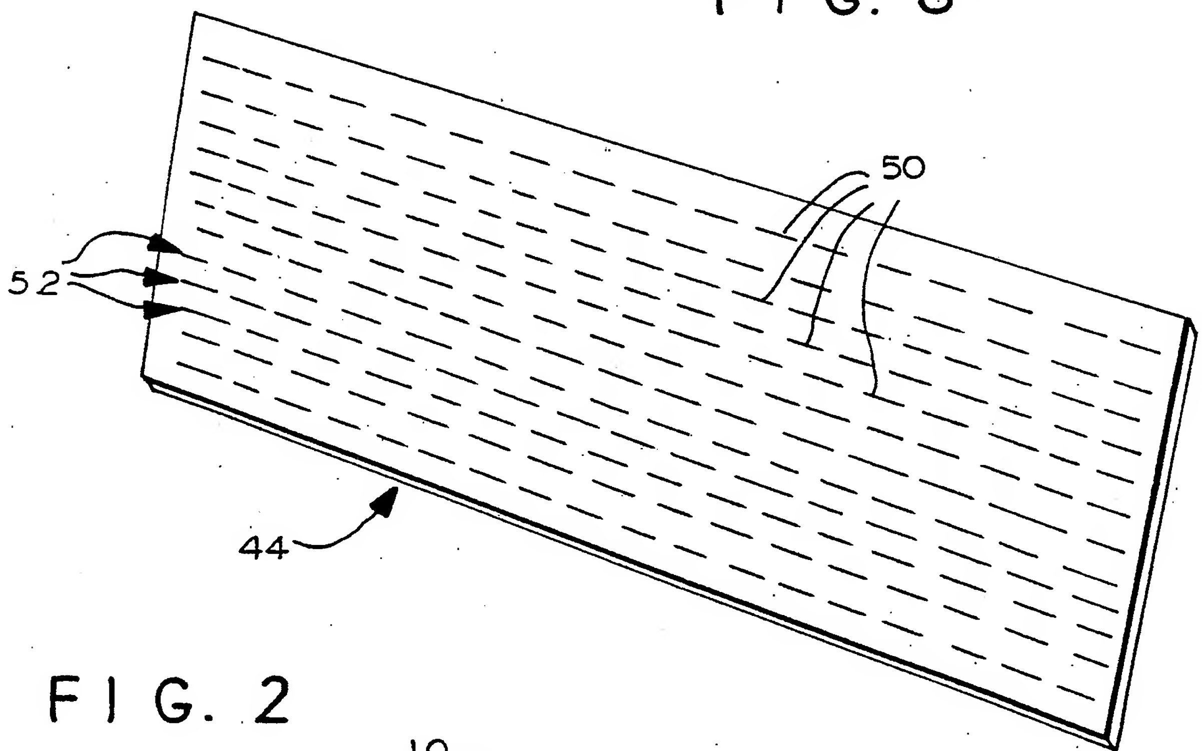

FIG. 2

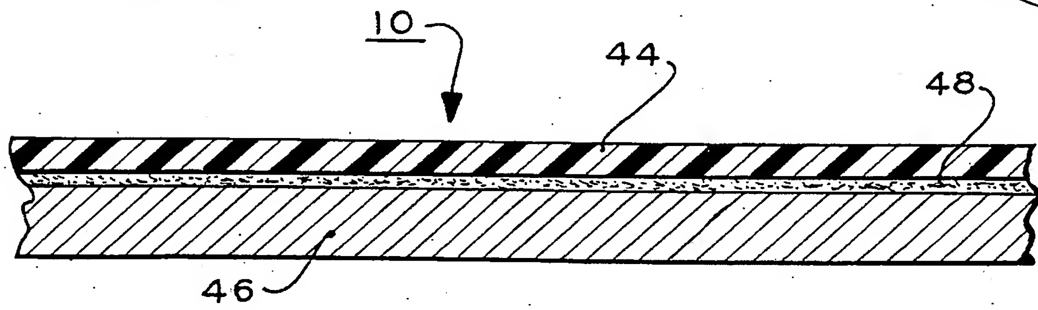

FIG. 2a

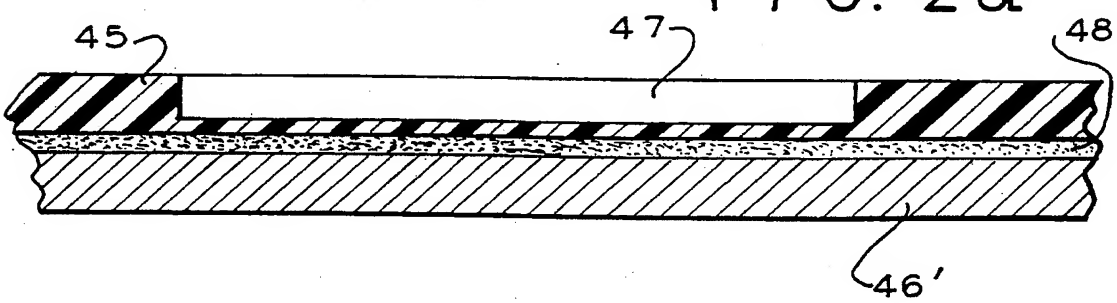

FIG. 4

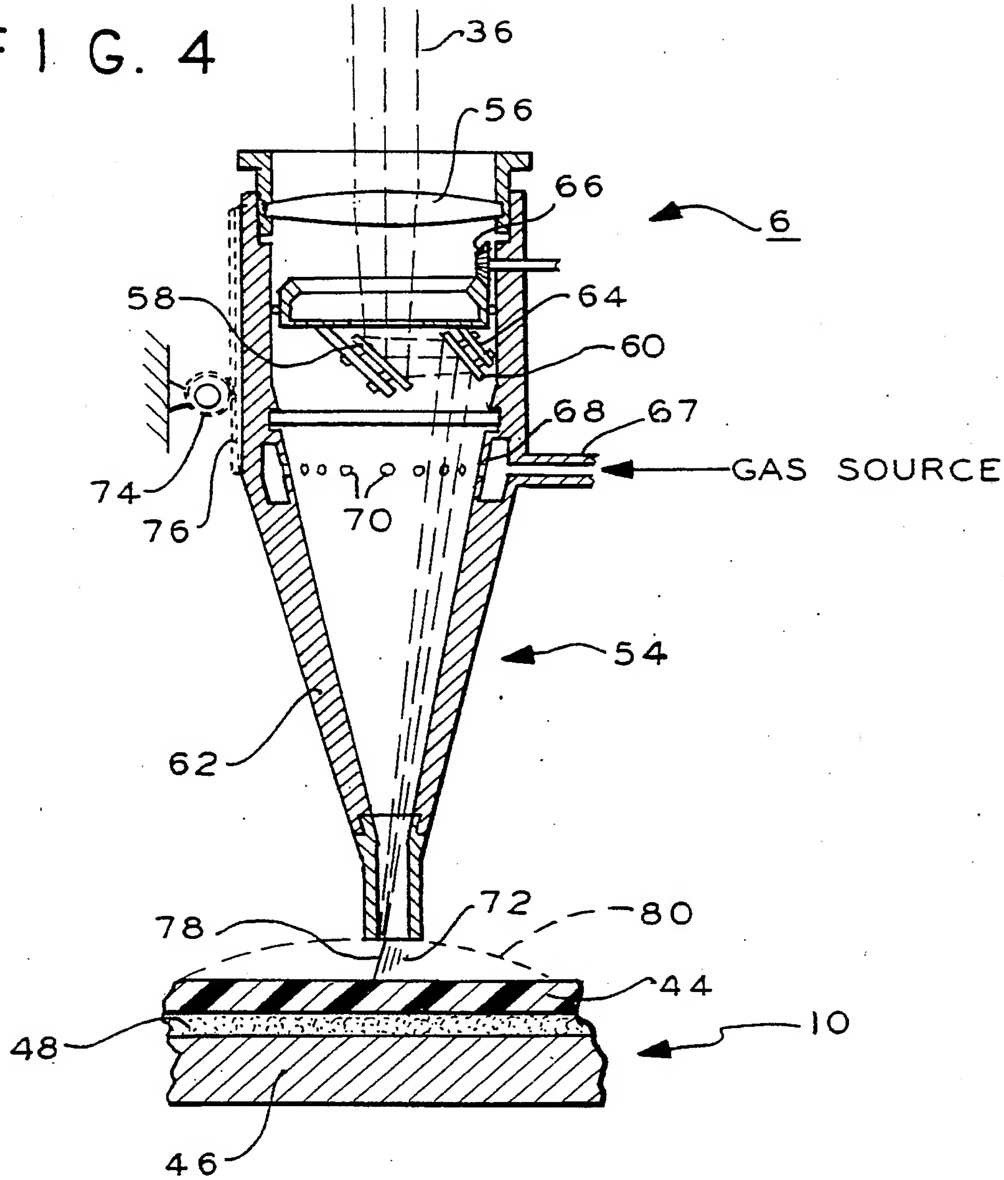
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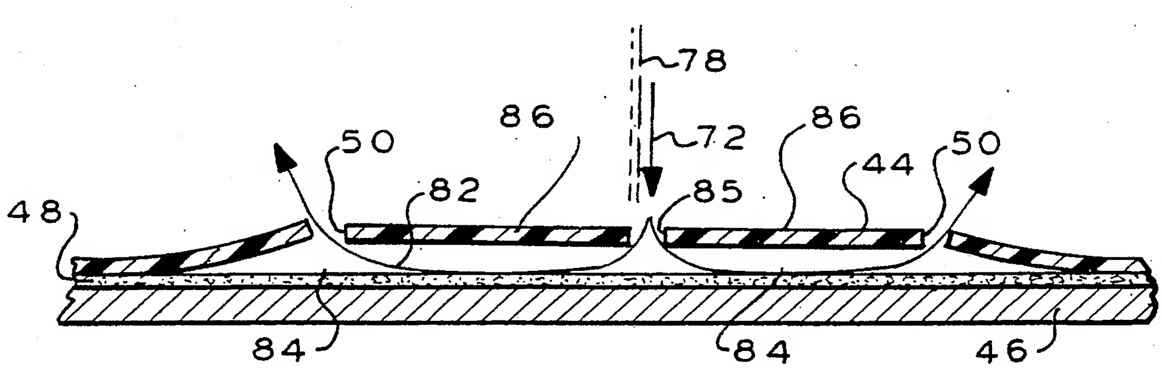
FIG. 5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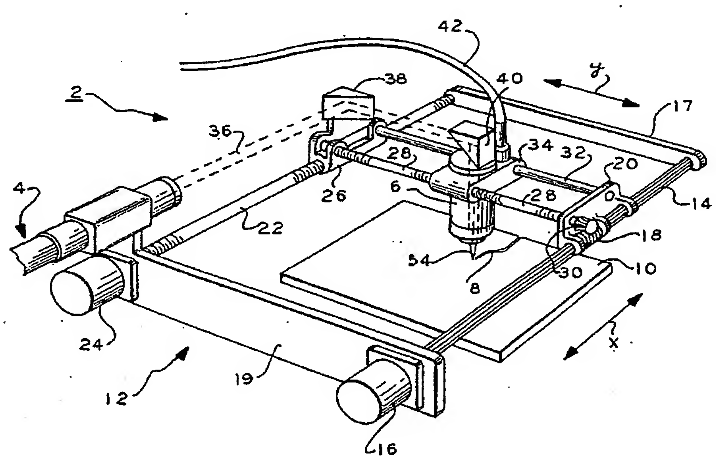
(54) Title: PROCESS FOR FORMING FILM COVERED SHEET METAL MATERIAL AND SHEET METAL MATERIAL SO COVERED



WO 01/41968 A3

(57) Abstract: A plastic film (44) is bonded with an adhesive (48) to a sheet metal substrate (46). The sheet metal substrate is processed in a laser operation to form grooves, openings or cuts in the sheet metal. The laser operation has a pressurized gas stream that is directed to the laser beam cut to clean and cool the cut. The gas enters the film-substrate interface at the opening formed by the beam. The film has slits (50) or other perforations throughout so that as the pressurized gas impinges upon the film and its opening formed by the laser beam and enters the film-substrate interface, the adjacent slits bleed the pressurized gas from the film-substrate interface to prevent significant lifting of the film from the substrate into a bubble which otherwise interferes with and can stop the laser operation. The perforations may be in the form of weakened recesses (47) in the film which open in reponse to lifting of the film by gas pressure at the interface with the underlying metal sheet. The dimensions of the perforations are such that the sheet metal is protected during prior handling and the laser processing while maintaining the integrity of the film so it can be easily removed as a unit and not shared during such removal.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/42043

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B23K26/18 B23K26/14 C09J7/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B23K C09J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, PAJ, EPO-Internal, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 59 147382 A (URABE TOSHINAGA) 23 August 1984 (1984-08-23) the whole document ---	1,9,19, 20
A	PATENT ABSTRACTS OF JAPAN vol. 014, no. 080 (C-0689), 15 February 1990 (1990-02-15) & JP 01 298113 A (HAJIME WATANABE), 1 December 1989 (1989-12-01) abstract ---	1,2,8,9, 19,20
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 September 2001	12/10/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Aran, D

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International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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